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BIOLOGICAL RESULTS OF THE UNIVERSITY OF MIAMI DEEP-SEA EXPEDITIONS. 76. CEPHALOPODS COLLECTED BY THE R/V JOHN ELLIOTT PILLSBURY IN THE GULF OF PANAMA IN 1967¹

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ABSTRACT

The cephalopod fauna of the Gulf of Panamá is reviewed, based mainly upon collections made by the R/V JOHN ELLIOTT PILLSBURY during 1967. Records are given of 812 specimens, of which four species and one genus are new to science: *Octopus selene*, *O. balboai*, *O. stictochrus* and *Euaxocephalus panamensis*. Twenty-six species are now known from the Gulf, of which 11 are new records first reported upon here. The relationships of the fauna of the Gulf of Panamá with those of the eastern Pacific and southwestern Caribbean Sea are discussed.

INTRODUCTION

The projected plans for constructing an interoceanic sea-level canal across the Isthmus of Panama to connect the waters of the Gulf of Panamá and the Caribbean Sea have aroused international interest in the faunas of the two regions. The fauna and flora of both areas are very poorly known, and before the land barrier is removed it is essential that studies be undertaken to list and describe the life involved. As part of the Rosenstiel School of Marine and Atmospheric Sciences' studies of this problem, the R/V JOHN ELLIOTT PILLSBURY entered the Gulf of Panamá in May 1967, to occupy a series of planned trawl stations on the continental slope and adjacent waters. The research conducted was part of a long-term study of the shallow- and deep-sea fauna of the tropical Atlantic and related regions. The research program was supported by the National Geographic Society-University of Miami Deep-Sea Biology Program. The ship time was supported by National Science Foundation grant GB-5776. The work on the octopods was subsidiary to National Science Foundation grants GB-1090 and GB-5729X.

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During the course of the cruise, 92 stations were occupied within the Gulf of Panamá from the shore to over 3200 meters. An account of the cruise and the station data have been given by the writer (Voss, 1967). Eight hundred and twelve specimens of cephalopods were taken, representing 17 species, of which four species and one genus were new to science.

I wish to thank Dr. Jon Staiger for his generous assistance in the sometimes arduous task of conducting the cruise. Without his help, little time would have been available to me for conducting shipboard studies of the cephalopods. I also wish to thank Dr. Lipke Holthuis and the graduate students of the School of Marine and Atmospheric Sciences who participated in the cruise, made the collections and contributed so greatly to its success. In particular I wish to thank Dr. Richard Young and Dr. Edward McSweeney, my graduate student colleagues in cephalopod research, who were largely responsible for the care, handling, and preserving of cephalopods collected and who made many observations on behavior and color. I wish to thank Dr. C. F. E. Roper and the Smithsonian Institution for the loan of a small collection of octopods from Panamá, including the type of *Octopus balboai*, and C. E. Dawson of the Gulf Coast Research Laboratory for permission to study a small collection of octopods from the coasts of Panamá and Costa Rica. The measurements and indices given in this paper are those defined by Voss (1963). The illustrations were executed by Constance Stolen McSweeney, to whom grateful thanks are extended.

The synonymies given in this paper are restricted to records of specimens from the Gulf of Panamá or to discussions concerning these records. The literature cited is likewise restricted to those papers dealing directly with the area under consideration.

HISTORICAL RÉSUMÉ

The cephalopod fauna of the Gulf of Panamá is very poorly known. Only three major expeditions have made even the most fragmentary collections from its waters and incidental shore collections have been inconsequential. Even some of the latter are not known to have been made specifically in the Gulf of Panamá. The present review is not exhaustive but it is believed to be nearly complete.

The first report of a cephalopod, presumably from the Gulf of Panamá, was given by Verrill (1883: 122), in his description of *Octopus bimaculatus*. He stated: "Numerous small specimens were obtained at Panamá and on the coast of San Salvador by Mr. Frank H. Bradley, for the Museum of Yale College, in 1866 and 1867." Pickford & McConnaughey (1949) considered these specimens to represent an as yet undescribed species, not a member of the *bimaculatus* complex.

In 1889, Jatta described the cephalopods taken on the circumnavigational cruise of the Italian school ship VETTOR PISANI. Among these was an un-

usual barred octopus, *Octopus chierchiae*, from the coast of Panamá, presumably in the gulf. This species was not again seen until Voss (1968) described and illustrated it anew from the PILLSBURY cruise of 1967.

The original fisheries research vessel ALBATROSS worked the entrance to the Gulf of Panamá in 1891, under the direction of Alexander Agassiz. No stations were made directly on the continental shelf; they were confined to the slope and the deep waters southward of the parallel of Punta Mala. For the purpose of this report, stations west of 81°W and south of 6°45'N are not included. Eight species of cephalopods were reported upon from this area by Hoyle (1904): *Calliteuthis reversa*, *Polypus* sp., *Tremoctopus scalenus*, *Bathyteuthis abyssicola*, *Moschites verrucosa*, *Mastigoteuthis dentata*, *Abraliopsis hoylei*, and *Abraliopsis* sp. Most of these specimens were taken at the deeper stations near the outer limits proposed here.

S. Stillman Berry, in 1911, described a new species of *Lolliguncula*, *L. panamensis*, from "Panama." It is known to occur in the Gulf of Panamá. In his monographic study of the oegopsid cephalopods, Pfeffer (1912) listed only two species from the area: *Abralia* (*Nepioteuthion*) *panamensis* (= *Abraliopsis* sp. Hoyle, 1904) and *Abralia* (*Micrabralia*) *affinis* (= *Abraliopsis hoylei*, Hoyle, 1904). Both of these species, however, belong to the genus *Abraliopsis* as originally cited by Hoyle (1904). *A. panamensis* was based upon a larval specimen and is here considered a *species dubia*.

Robson (1929, 1932), in his monograph of the Octopodidae, listed 12 species of octopods from "Panama." Most of these were citations of species given above or species from outside our area of reference. It would serve no purpose to relist them here, except for *Argonauta argo*, *A. nouryi*, and *A. cornutus*, all without specific locality data.

In 1921, Schmidt took the DANA briefly into the eastern Pacific. The material from this cruise was reported upon by Joubin (1929, 1931). Among the new species described were three emanating from the Gulf of Panamá or its immediate environs: *Retroteuthis pacifica*, *Valbyteuthis danae* and *Drechselia danae*, the latter just south of latitude 6°45'N, at 6°40'N.

Roper (1968) described a new species of *Bathyteuthis*, *B. bacidifera*, from the Eastern Pacific Equatorial Water Mass. A specimen collected on the PILLSBURY cruise served as one of the paratypes, as well as a specimen taken by the DANA from the environs of the Gulf of Panamá. In 1969, Roper recorded additional DANA material belonging to this species from the same area.

In 1968, I redescribed and illustrated *Octopus chierchiae* from stations deep within the gulf. No additional specific records of cephalopods from this region are known to me. However, a few species should be included, because of their wide range along the west American coast. These are *Dosidicus gigas* and *Symplectoteuthis oualaniensis*. The first is confirmed

in the present report; surprisingly, no specimens of the latter were taken during the PILLSBURY cruise.

A list of the species now known to occur within the Gulf of Panamá is given below. Those whose names are preceded by single asterisks were taken also by the PILLSBURY. The names given are those presently accepted by specialists in this group. The names given in prior reports are enclosed within parentheses preceded by an = sign. Double asterisks represent new records for the Gulf of Panamá.

LIST OF CEPHALOPODS KNOWN TO OCCUR IN THE GULF OF PANAMÁ

- ***Loliolopsis diomedee* (Hoyle, 1904), new combination
- **Lolliguncula panamensis* Berry, 1911
- **Abraliopsis affinis* (Pfeffer, 1912) (= *Abraliopsis hoylei*, Hoyle, 1904)
- ***Pterygoteuthis giardi* (?) Fischer, 1895
- ***Onychoteuthis banksi* (Leach, 1817)
- **Bathyteuthis bacidifera* Roper, 1968
- Bathyteuthis abyssicola* Hoyle, 1885
- ***Dosidicus gigas* (d'Orbigny, 1835)
- Symplectoteuthis oualaniensis* (Lesson, 1830)
- Histioteuthis* sp. (= *Calliteuthis reversa* Verrill, 1880)
- Mastigoteuthis dentata* Hoyle, 1904
- Valbyteuthis danae* Joubin, 1931
- Drechsalia danae* Joubin, 1931
- ***Japetella diaphana* Hoyle, 1885
- ***Octopus selene*, new species
- ***Octopus balboai*, new species
- ***Octopus stictochrus*, new species
- **Octopus chierchiae* Jatta, 1889
- ** ? *Octopus oculifer* (Hoyle, 1904) (? = *O. bimaculatus* Verrill, 1883, *pars*)
- ** ? *Octopus vulgaris* Cuvier, 1797
- ***Euaxocephalus panamensis*, new genus & new species
- **Argonauta pacificus* Dall, 1872
- **Argonauta cornutus* Conrad, 1854
- **Argonauta nouryi* Lorois, 1852
- Tremoctopus violaceus* delle Chiaje, 1830 (= *Tremoctopus scalenus* Hoyle, 1904)
- Vampyroteuthis infernalis* Chun, 1903 (= *Retroteuthis pacifica* Joubin, 1929)

GEOGRAPHICAL DISCUSSION

Any detailed discussion of the geographical distribution of cephalopods is premature. There are still many areas that have not been sampled and reported upon. In addition, newer types of trawls are capturing species new to old and well-worked areas. Nevertheless, it is possible to show certain broad affinities and patterns, always realizing that these are subject to modification with addition of new data.

The picture of cephalopod distributional patterns in the eastern Pacific is complicated by our general lack of knowledge of the cephalopod faunas along the western coasts of North and South America. Despite the long

history of cephalopod research in California, primarily the work of S. Stillman Berry, there is no modern monographic treatment of the cephalopods of those waters. The situation with regard to the octopods is particularly frustrating. Numerous species of small octopods have been described, but the descriptions are very brief, there is a complete void of morphometric data, and most have never been illustrated. The situation with regard to western South America is even worse; here we must rely almost solely upon the mid-nineteenth century work of Alcide d'Orbigny.

The presently known species of cephalopods recorded from the Gulf of Panamá and its environs amount to 26 species. An analysis of these shows that they are divisible into four faunal components: Endemic Tropical Eastern Pacific, Temperate Eastern Pacific, Indo-Pacific, and Cosmopolitan Warm-Temperate.

TABLE 1
LIST OF ENDEMIC TROPICAL EASTERN PACIFIC CEPHALOPODS

| | |
|--------------------------------|-------------------------------|
| <i>Loliolopsis diomedae</i> | <i>Octopus selene</i> |
| <i>Lolliguncula panamensis</i> | <i>O. balboai</i> |
| <i>Abrialiopsis affinis</i> | <i>O. stictochrus</i> |
| <i>Drechselia danae</i> | <i>O. chierchiaie</i> |
| <i>Mastigoteuthis dentata</i> | <i>O. oculifer</i> |
| | <i>Euaxoctopus panamensis</i> |

Endemic Tropical Eastern Pacific.—This is the largest faunal element and amounts to 42 per cent of the total, or 11 species. In contrast to the Gulf of Guinea (Voss, in press) a somewhat comparable area that has no endemic genera, this region possesses three—*Loliolopsis*, *Drechselia*, and *Euaxoctopus*. *Loliolopsis* and *Euaxoctopus* will probably prove to be truly endemic; *Drechselia* is doubtful, because it is a bathypelagic form, and such forms usually have wide oceanic distributions. *Loliolopsis diomedae* is unique. *Lolliguncula panamensis* is obviously a Tethyan species and is closely related to *L. brevis* from the western Atlantic, with which it may be identical. The genus is represented in the eastern Atlantic by *L. mercatoris*, and in the western Indian Ocean by *L. abulati*. *Abrialiopsis affinis* is closely related to an undescribed species in the Atlantic and other species in the tropical Pacific and Indian oceans. *Mastigoteuthis dentata*, similar to *Drechselia danae*, is bathypelagic, but so far is known only from the Gulf of Panamá and the Galapagos Islands.

The octopods—*Octopus selene*, *O. balboai*, *O. chierchiaie*, *O. oculifer*, and *Euaxoctopus panamensis*—are all endemic. *O. chierchiaie* is closely related to *O. zonatus* from the Caribbean, and *O. oculifer* may be a Pacific counterpart of *O. hummelincki* from the Caribbean. *Euaxoctopus* has no known representative elsewhere.

TABLE 2
LIST OF TEMPERATE EASTERN PACIFIC CEPHALOPODS

| | |
|------------------------|----------------------------|
| <i>Dosidicus gigas</i> | <i>Argonauta pacificus</i> |
|------------------------|----------------------------|

Temperate Eastern Pacific.—These cephalopods are found well beyond the boundaries of the tropical eastern Pacific region, occurring southward perhaps as far as Chiloe Island and northward off California. There are only two species, which account for 8 per cent of the fauna.

TABLE 3
LIST OF INDO-PACIFIC CEPHALOPODS

| | |
|--------------------------------------|---|
| <i>Symplectoteuthis oualaniensis</i> | <i>Argonauta cornutus</i> <i>A. nouryi</i> |
|--------------------------------------|---|

Indo-Pacific.—It is surprising that so few cephalopods from the great Indo-Pacific area have found their way to the coasts of the Americas. These would of necessity, in order to cross the eastern Pacific basin, be either oceanic species or forms with long-duration planktonic larvae. Only three are so far known, accounting for 12 per cent of the fauna. *Symplectoteuthis oualaniensis* is an Indo-Pacific oceanic and slope-associated form. *Argonauta cornutus* and *A. nouryi* are somewhat problematical species which appear to have a wide distribution in the Central Pacific area.

TABLE 4
LIST OF COSMOPOLITAN WARM-TEMPERATE CEPHALOPODS

| | |
|--------------------------------|----------------------------------|
| <i>Pterygioteuthis giardi</i> | <i>Japetella diaphana</i> |
| <i>Onychoteuthis banksi</i> | <i>Octopus vulgaris</i> |
| <i>Bathyteuthis abyssicola</i> | <i>Tremoctopus violaceus</i> |
| <i>B. bacidifera</i> | <i>Vampyroteuthis infernalis</i> |
| <i>Histioteuthis</i> sp. | |
| <i>Valbyteuthis danae</i> | |

Cosmopolitan Warm-Temperate Cephalopods.—This is the second largest group, comprising 38 per cent of the fauna of the Gulf of Panamá. The decapods all belong to the bathypelagic zone, an area noted for the wide distribution of its inhabitants. The octopods are either pelagic (*Japetella diaphana* and *Tremoctopus violaceus*) or bathypelagic (*Vampyroteuthis infernalis*). *Octopus vulgaris* lays small eggs and has small, planktonic larvae that can maintain themselves in the plankton for long periods of time. This species is the most widely distributed of all benthic octopods.

Among the cephalopods of the Gulf of Panamá are three species which have perhaps their closest relatives in the Caribbean Sea. These have often been termed geminate species. One of the most striking of these is *Octopus chierchiae*. Its relative in the Caribbean is *O. zonatus*, from which it is quite distinct but can be distinguished only by careful examination. Undoubtedly these two were derived from a common immediate ancestor, or one from the other. Similarly, *Octopus oculifer* is very closely related to *O. hummelincki*, the common ocellated octopus of the Caribbean. *O. oculifer* is also, however, closely allied perhaps to the *bimaculatus-bimaculoides* complex of the California coast. In the case of the *Lolliguncula panamensis*-*L. brevis* complex, we are, as stated above, dealing with a Tethyan distribution. However, so few specimens of *L. panamensis* have been taken that its status is still somewhat problematical.

A comparison of the faunas of the total tropical eastern Pacific and the Caribbean will somewhat change the picture presented here. As our sampling, however, was restricted to the Gulf of Panamá and records outside of it are few and doubtful, the larger analysis must be delayed until better data are available.

Order TEUTHOIDEA

Suborder Myopsida

Family Loliginidae

Loliolopsis diomedae (Hoyle, 1904), new combination

Loligo diomedae Hoyle, 1904: 29, pl. 5, fig. 13; pl. 6, figs. 1-7.

Loliolopsis chiroctes Berry, 1929: 267, figs. 1-9, pls. 32-33.

Material Examined.—Type of *Loligo diomedae*, ♀, mantle length 85 mm, ALBATROSS Sta. 3422, off Acapulco, 16°47'30"N, 99°59'30"W, 141 fm, green mud, April 12, 1891, USNM 574847.—1 ♂, mantle length 79.0 mm, PILLSBURY Sta. 531, 8°25.5'N, 79°10.1'W, west of the Perlas Islands, Panamá, in 57-64 meters with 10-ft OT, May 6, 1967.—2 ♂, mantle length 66-58 mm, PILLSBURY Sta. 548, 8°09.8'N, 78°25'W, in 18-20 meters off Punta Garachiné, Panamá, with 16-ft OT, May 7, 1967.—2 ♂, mantle length 49-59 mm, PILLSBURY Sta. 546, 8°19.2'N, 78°35.8'W, in 27-31 meters in the Bahia San Miguel with 10-ft OT, May 7, 1967.—2 ♂, mantle length 44-46 mm, PILLSBURY Sta. P-495, 7°59.2'N, 80°00.2'W, in 40-37 meters off Punta Mala, Panamá, with 10-ft OT, May 2, 1967.—3 ♀, mantle length 99-106 mm, PILLSBURY Sta. 563, 8°14.8'N, 78°56.2'W, at the surface with night light and dip net off Punta del Concholon, Isla del Rey, Perlas Islands, May 8, 1967.—4 ♂, mantle length 57-78 mm, 5 ♀, mantle length 89-102 mm, PILLSBURY Sta. 534, 8°54.5'N, 79°10.2'W, in 17 meters off Isla Chipillo with 10-ft OT, May 6, 1967.—176 ♂, mantle length 60-92 mm, 247 ♀, mantle length 63-97 mm, PILLSBURY Sta. 518, 8°00'N, 79°31.1'W, in 99-95 meters in the middle of the Gulf of Panamá with 40-ft

OT, May 4, 1967.—8 ♂, mantle length 64-77 mm, 156 ♀, mantle length 88-113 mm, PILLSBURY Sta. 554, 7°59'N, 79°02.2'W, at surface south of the Perlas Islands with night light and dip net, May 7, 1967.

Remarks.—This species occurs in large numbers in the Gulf of Panamá and should be able to support a considerable fishery. The females seem to be more numerous than the males (about a 2:1 ratio), but collecting methods were not adequate for eliminating bias. The males are smaller than the females and are easily distinguished by the great length and whip-like appearance of the left ventral arm. The right ventral arm is normal, except for the development of a broad ventral membrane about midway of the arm.

When the schools were drawn together under the night light on several occasions, the animals went into a mating frenzy, dashing about frantically and discharging spermatophores at random.

The animals conform well with the description given by Berry (1929). The species is known from the Gulf of California to Peru.

Discussion.—In 1904, Hoyle reported upon the collections made by the ALBATROSS off Central America and the west coast of Mexico. In his report, he described a new species of *Loligo*, *L. diomedae*, based upon a single female from off Acapulco. No additional information has been given for this species since Hoyle's report. The type is in the U. S. National Museum and is now so hardened that little can be determined from examination of it.

In 1929, Berry described a new genus and species, *Loliolopsis chiroctes*, from the Gulf of California. The male is distinctive, and Berry erected a new genus to contain it. It was well illustrated and described.

During the PILLSBURY cruise of 1967 in the Gulf of Panamá, females of a loliginid were collected under the night light and, when checked against Hoyle's paper, were immediately identified as *Loligo diomedae*. However, when males were examined, they were found to conform to Berry's description of *Loliolopsis chiroctes*. A careful check of the two descriptions and an examination of the type of *L. diomedae* have convinced me that the two species are identical. As Hoyle's name has precedence by some 23 years, Berry's name *chiroctes* must unfortunately be placed in synonymy. His generic name, however, is apparently valid, and the new combination results in the name *Loliolopsis diomedae*.

Lolliguncula panamensis Berry, 1911

Lolliguncula (?) *panamensis* Berry, 1911: 100, figs. 1-7, pl. 6.

Material Examined.—2 ♀, mantle length 46-52 mm, PILLSBURY Sta. 537, 8°35.7'N, 78°41.7'W, at surface between the Perlas Islands and Río Hondo, Panamá, with night light and dip net, May 7, 1967.

Only two small females were taken. They seem assignable to this species, which is known to occur from Panamá to Ecuador. Much more needs to be learned about this poorly described and little studied species.

UNIDENTIFIED LOLIGINIDS

Material Examined.—1 juvenile, mantle length 18 mm, from PILLSBURY Sta. 548.—1 juvenile, mantle length 21 mm, PILLSBURY Sta. 546.—1 juvenile, mantle length 12 mm, PILLSBURY Sta. 534.—4 juveniles, mantle length 20.0-35.0 mm, PILLSBURY Sta. 544.

The above listed juveniles are too immature for positive identification, due to our lack of knowledge of the life histories of Panamanian loliginids.

LOLIGINID EGG MASSES

Large egg masses of the type deposited by loliginids were collected at the following PILLSBURY stations: 488, 534, 544, 547, 548. Since individuals of *Loliolopsis diomedea* were spawning at this time, it is possible that these eggs can be associated with this species. Individual egg capsules were up to 35 mm long and contained numerous eggs enclosed in the gelatinous mass.

Suborder Oegopsida

Family Enoploteuthidae

Abraliopsis affinis (Pfeffer, 1912)

Abraliopsis hoylei, Hoyle, 1904: 36, pl. 1, fig. 3; pl. 8, pl. 10, figs. 1-10 (not *Abraliopsis hoylei* [Pfeffer, 1884]).

Abralia (*Micrabralia*) *affinis* Pfeffer, 1912: 160.

Material Examined.—1 ♂, mantle length 25 mm, 5 ♀, mantle length 18-27 mm, 1 head, PILLSBURY Sta. 510, 6°54'N, 79°57.6'W, in 3182-3164 meters south of Punta Mala, Panamá, with 40-ft OT, May 3, 1967.

This is a very common species occurring from the Gulf of Panamá northward to southern California and in the tropical eastern Pacific.

Pterygioteuthis giardi(?) Fischer, 1895

Material Examined.—2 juveniles, mantle length 16-19 mm, PILLSBURY Sta. 510, 6°54'N, 79°57.6'W, in 3182-3164 meters south of Punta Mala, Panamá, with 40-ft OT, May 3, 1967.

Only two badly injured specimens of this widely distributed species were taken on the cruise.

Family Onychoteuthidae

Onychoteuthis banksi (Leach, 1817)

Material Examined.—2 juveniles, mantle length 23-34 mm, PILLSBURY Sta. 511, 7°16.2'N, 79°50.8'W, at surface off Punta Mala, Panamá, with night light and dip net, May 3, 1967.

Remarks.—This is a common pelagic species of nearly cosmopolitan distribution, but which may eventually be split up into a number of species.

Family Bathyteuthidae

Bathyteuthis bacidifera Roper, 1968

Bathyteuthis bacidifera Roper, 1968: 163, pls. 1-4, 7G, H; 1969: 43, pls. 6-10, 12G, H.

Material Examined.—PARATYPE: 1 ♂, mantle length 28 mm, PILLSBURY Sta. 510, 6°54'N, 79°57'W, south of Punta Mala, Panamá, 0-3182 meters, with 40-ft OT, May 3, 1967.

This specimen was reported upon by Roper (1968). It was captured together with two unidentified individuals of *Mastigoteuthis*. This species appears to be restricted to the waters of the Eastern Pacific Equatorial Water Mass, but possibly occurs in the Indian Ocean Equatorial Water Mass (Roper, 1969).

Family Ommastrephidae

Dosidicus gigas (d'Orbigny, 1835)

Material Examined.—5 juveniles, mantle length 51-114 mm, PILLSBURY Sta. 511, 7°16.2'N, 79°50.8'W, southeast of Punta Mala, Panamá, at surface with night light and dip net, May 3, 1967.—3 juveniles, mantle length 24-50 mm, PILLSBURY Sta. 503, 7°24.5'N, 79°45.2'W, east of Punta Mala, Panamá, at surface with night light and dip net, May 3, 1967.

This species was taken only at two stations near the mouth of the Gulf of Panamá. It is distributed seasonally from San Diego, California, to Chile. While it attains a large size, most individuals seen are the younger stages common in near-shore locations. It is not common in the Gulf of Panamá proper.

Family Mastigoteuthidae

Mastigoteuthis sp.

Material Examined.—2 specimens, sex indet., mantle length 49-83 mm, PILLSBURY Sta. 510, 6°54'N, 79°57.6'W, south of Punta Mala, Panamá, 0-3182 meters with 40-ft OT, May 3, 1967.

The two specimens were rather badly mangled by the trawl and may be unidentifiable. The genus *Mastigoteuthis* is sorely in need of a full revision based upon adequate material not yet available. The ALBATROSS in 1891 took a specimen of *Mastigoteuthis* within a few miles of this station, which Hoyle (1904) called *M. dentata*. Whether the PILLSBURY specimens belong to the same species cannot at present be decided.

Order OCTOPODA

Suborder Incirrata

Family Bolitaenidae

Japetella diaphana Hoyle, 1885

Japetella diaphana, Thore, 1949: 4.

Material Examined.—1 juvenile, mantle length 13 mm, PILLSBURY Sta. 510, 6°54'N, 79°57.6'W, south of Punta Mala, Panamá, 0-3182 meters with 40-ft OT, May 3, 1967.

This species has been reported previously from the Gulf of Panamá by Thore (1949). It is a cosmopolitan species.

Family Octopodidae

Octopus selene, new species

Fig. 1, a-i

Material Examined.—HOLOTYPE: ♂, mantle length 39.2 mm, PILLSBURY Sta. 501, 7°50.2'N, 79°50.5'W, northeast of Punta Mala, Panamá, in 68 meters with 10-ft OT, May 2, 1967. USNM 577617.

PARATYPES: 3 ♂, mantle length 33.1-34.3 mm, 6 ♀, mantle length 33.2-38.9 mm, PILLSBURY Sta. 498, 8°10.5'N, 79°50.2'W, western Gulf of Panamá, in 58 meters with 10-ft try net, May 2, 1967.—9 ♂, mantle length 30.0-41.0 mm, 11 ♀, mantle length 30.5-42.9 mm, PILLSBURY Sta. 500, 7°59.7'N, 79°49.7'W, western Gulf of Panamá, in 53 meters with 10-ft OT, May 2, 1967.—35 ♂, mantle length 32.2-42.8 mm, 17 ♀, mantle length 28.0-40.9 mm, PILLSBURY Sta. 501, 7°50.2'N, 79°50.5'W, northeast of Punta Mala, Panamá, in 68 meters with 10-ft OT, May 2, 1967.—1 ♀, mantle length 30.0 mm, PILLSBURY Sta. 512, 7°30.5'N, 79°41.5'W, east of Punta Mala, Panamá, in 210 meters with 10-ft OT, May 4, 1967.—2 ♀, mantle length 36.9-55.2 mm, PILLSBURY Sta. 513, 7°39.5'N, 79°40.7'W, east of Isla Iguana, Panamá, in 117 meters with 10-ft OT, May 4, 1967.—14 ♂, mantle length 29.0-40.4 mm, 21 ♀, mantle length 26.4-40.9 mm, PILLSBURY Sta. 515, 8°00.4'N, 79°40.8'W, in western Gulf of Panamá, in 79-77 meters with 10-ft OT, May 4, 1967.—1 ♂, mantle length 37.2 mm, 5 ♀, mantle length 34.7-44.1 mm, PILLSBURY Sta. 519, 7°59.4'N, 79°34.3'W, central Gulf of Panamá, in 88 meters with 10-ft OT, May 4, 1967.—4 ♂, mantle length 30.8-40.4 mm, 13 ♀, mantle length 32.1-47.9 mm, PILLSBURY Sta. 529, 8°00.7'N, 79°11.8'W, south of Isla de San Jose, Perlas Islands, Panamá, in 84 meters with 10-ft OT, May 6, 1967.—1 ♀, mantle length 58.1 mm, PILLSBURY Sta. 555, 7°50.7'N, 79°00.3'W, south of the Perlas Islands, Panamá, in 68 meters with 10-ft OT, May 7, 1967.—1 ♀, mantle

length 43.2 mm, PILLSBURY Sta. 558, 7°50.7'N, 78°38.3'W, southwest of Punta Escondido, Panamá, in 62-60 meters with 10-ft OT, May 8, 1967.

Description.—This species is represented in the PILLSBURY collections by 144 specimens collected at nine stations in the Gulf of Panamá. It is a moderately small species, but very common in the places of capture. The indices given are for specimens in the 40-45 mm size-groups, although the five largest females exceeded this limit, with a maximum of 58 mm. The sexes were about evenly distributed with 69 males and 76 females.

The mantle is stout and rounded in the adult females (MWI 58.8-7.37-86.4), but in younger specimens is somewhat flattened. In the males (MWI 49.7-61.9-72.8), the mantle is more elongate and is bluntly pointed posteriorly and more flattened ventrally.

The funnel is short, stout, and is free for about half of its length. The funnel organ is W-shaped, with the outer limbs as long as the median projection. The mantle aperture is wide.

The head is narrower than the mantle and is only slightly set off by an inconspicuous constriction in the neck region (δ HWI 38.5-44.1-50.7; η HWI 29.5-45.6-63.4).

The web is moderately shallow (WDI δ 18.5-22.2-28.0; η 20.4-24.7-29.5), and the web formula is very variable. In general, sectors C and D are the deepest, but occasionally A or E is deepest. The web extends out along the ventral side of the arms for about two-thirds of their length.

The arms are of medium length (ALI δ 56.2-60.7-65.9; η 57.4-62.0-68.2) with the formula 3.2.4.1 or 4.3.2.1. The suckers are not large (SIn δ 8.6-9.9-11.1; η 7.4-9.3-11.3) and are evenly spaced, separate, and erect. While the sucker index of the males is slightly larger than of the females, there are no specially enlarged suckers describable in the males.

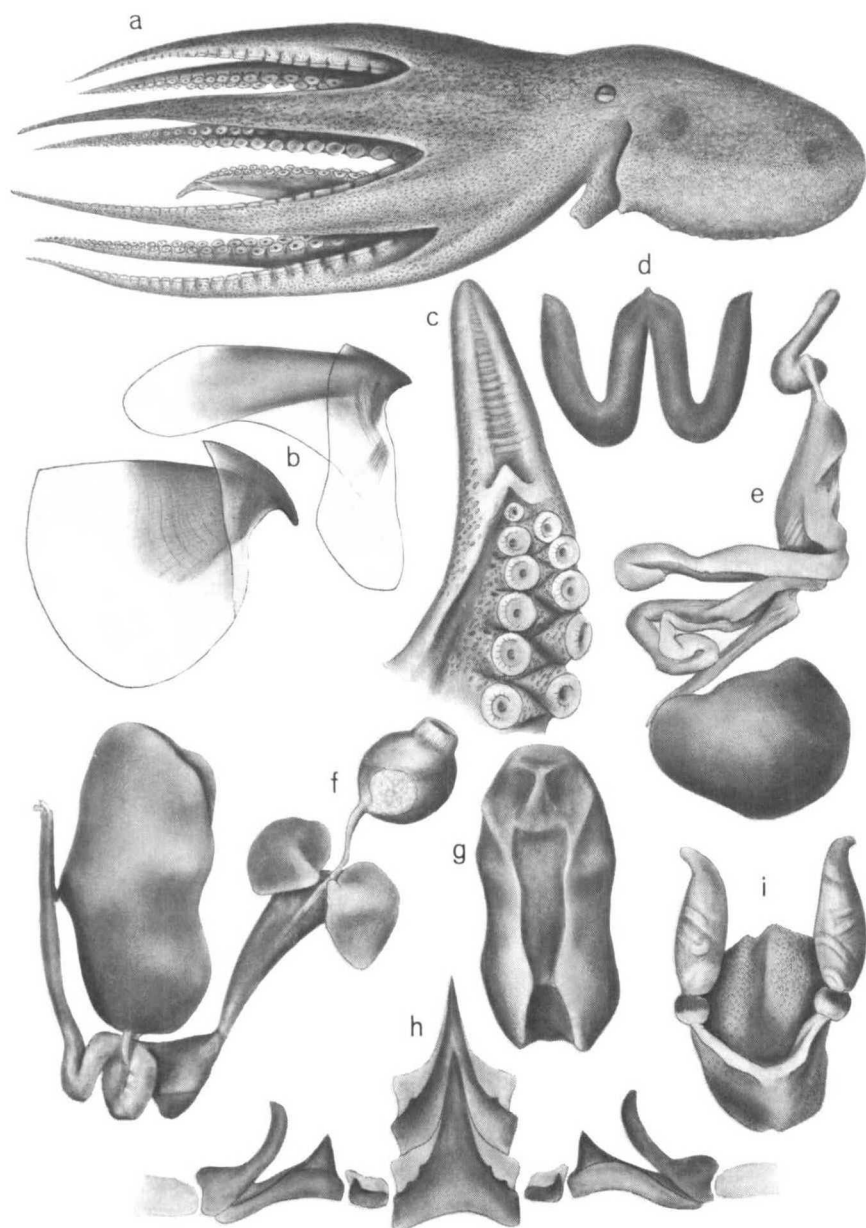
In the males the third right arm is hectocotylyzed. It is a little shorter than its fellows (HcAI 72.0-77.5-83.5) and is bordered ventrally by a stout, inrolled membrane forming the spermatophoral groove. The ligula is small (LLI 5.0-7.3-10.0), narrow, and pointed, with inrolled margins and a distinct longitudinal groove. There are traces of transverse rugae. The calamus is short (CLI 15.0-19.4-26.3) and lies closely adhering to the ligula.

The gills are large. The outer demibranch bears about 12 to 16 lamellae, with a distinct average of 13-14.

The mandibles are as figured.

→

FIGURE 1. *Octopus selene*, new species: a, lateral view of holotype, 39.2 mm mantle length; b, upper and lower beaks; c, distal portion of hectocotylyzed arm of holotype; d, funnel organ; e, male reproductive tract; f, digestive tract; g, dorsal view of liver; h, radula; i, female reproductive tract.



The radula is not distinctive. The rachidian teeth show an A^{3-4} seriation, although the cusps are small. The admedians are small, with a small, erect ectocone near the outer end of the tooth. The second lateral has a long base, with a broad, erect cusp near the inner end. The third laterals are of the long, slender, sabre type. The marginals are undeveloped and rectangular in shape.

The digestive tract was removed from the largest female. There are two large, leaflike posterior salivary glands and a large and conspicuous crop. The stomach is large and separated from the spiral caecum. The intestine does not appear differentiated and terminates with a pair of anal flaps. The ink sac is large and deeply set into the liver.

The female genitalia consist of a large ovary with numerous small eggs which appear nearly mature. They are 1.6×0.3 mm, with a short stalk. The proximal oviducts have a common pore and branch immediately, but are small in diameter. The oviducal gland is also small. The distal oviducts are very large and swollen, and both are filled with spermatophores.

The male genitalia are of the usual type. The penis is long and slender, with a short diverticulum. However, in some specimens the penial apparatus appears more as a loop, as shown in the figure.

The sculpture consists of low papillae or rugosities over the dorsal area of the mantle, head and arms. This is a variable feature, however, and some specimens are smooth, or nearly so.

The color in alcohol is light to dark reddish purple on the dorsum, light to pale brown on the ventrum, with several large dark spots or splotches on the mantle. Two are placed far posteriorly on the mantle and two more, one on each side, near the origin of the mantle aperture.

Type.—U. S. National Museum 577617.

Type-Locality.—PILLSBURY Sta. 501, $7^{\circ}50.2'N$, $79^{\circ}50.5'W$, northeast of Punta Mala, Panamá, in 68 meters with 10-ft OT, May 2, 1967.

Discussion.—This species does not appear to be closely related to any of the known eastern Pacific octopods. Although some of the octopods reported from the Pacific coast by early workers are so poorly known as to be almost unrecognizable, the present material appears to represent a new species, and it is here so considered.

The specimens were so numerous at two stations that it was calculated there were about one and a half octopuses per square meter. They were found on sandy and rocky bottom, along with such other animals as the mollusks *Calliostoma*, *Polinices*, and *Tellina*, the worm *Aphrodite* and amphinomids, the crustaceans *Squilla*, *Solenocera*, *Clibanarius*, and *Dardanus*, the echinoderm *Clypeaster*, and fishes of the genera *Scorpaena*, *Porichthys*, *Prionotus*, and *Symphurus*.

Remarks.—The specific name *selene* is from the Greek word *selene*, the moon, and is given in recognition of the first moon landing by the U. S. Astronauts Armstrong and Aldrin on July 20, 1969. This description was written on the day they lifted off from the moon's surface to return to the earth.

TABLE 5
MEASUREMENTS (IN MM) AND COUNTS OF 11 MALES AND 20 FEMALES OF
Octopus selene, NEW SPECIES

| | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ |
|-----------------|------|------|------|------|------|------|------|------|------|------|
| Mantle length | 40.0 | 40.0 | 40.2 | 40.5 | 40.5 | 40.9 | 40.9 | 42.1 | 42.9 | 42.9 |
| Mantle width | 32.8 | 29.9 | 29.3 | 28.9 | 28.6 | 29.3 | 25.0 | 36.4 | 38.0 | 38.0 |
| Head width | 19.0 | 18.1 | 21.0 | 20.0 | 18.8 | 21.0 | 19.2 | 18.1 | 19.1 | 19.1 |
| Arm length I | 80.5 | — | 83.2 | — | 69.1 | 72.8 | 61.0 | 84.6 | 75.8 | 75.8 |
| II | 88.5 | 75.0 | 79.9 | — | 79.1 | 78.3 | 68.9 | — | 81.1 | 81.8 |
| III | 90.8 | 81.1 | 89.5 | — | — | — | 64.5 | — | 88.0 | 88.0 |
| IV | 86.0 | 88.9 | 82.4 | — | 86.5 | 89.0 | 63.8 | 86.9 | 83.1 | 83.1 |
| Sucker diameter | 4.0 | 4.2 | 3.9 | 3.5 | 4.6 | 4.2 | 3.5 | 4.0 | 3.2 | 3.2 |
| Arm width | 6.0 | 5.9 | 6.1 | 6.5 | 5.1 | 6.0 | 5.4 | 6.0 | 7.5 | 7.5 |
| Gills | 14 | 13 | 14 | 14 | 14 | 14 | 14 | 13 | 14 | 14 |
| Web depth A | — | — | 18.9 | 13.5 | 18.0 | 12.2 | 16.3 | — | — | — |
| B | 17.0 | 23.9 | 23.8 | 13.7 | 18.5 | 14.0 | 17.0 | 21.1 | 24.0 | 24.0 |
| C | 16.1 | 21.8 | 22.9 | 16.0 | — | — | 17.5 | 20.6 | 22.3 | 22.3 |
| D | 22.0 | — | — | — | — | — | 20.0 | 20.5 | 26.0 | 26.0 |
| E | 14.8 | 14.9 | 20.5 | — | — | 19.0 | 15.0 | 19.5 | 24.3 | 24.2 |

| | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ | ♀ |
|-----------------|------|-------|------|------|------|------|------|------|-------|-------|
| Mantle length | 43.0 | 43.2 | 43.7 | 44.0 | 44.1 | 45.4 | 45.7 | 47.9 | 55.2 | 58.1 |
| Mantle width | 30.9 | 29.2 | 31.9 | 26.8 | 31.5 | 26.7 | 31.1 | 37.4 | 43.2 | 46.0 |
| Head width | 17.9 | 19.9 | 18.9 | 18.0 | 21.0 | 19.2 | 29.0 | 19.1 | 26.9 | 25.8 |
| Arm length I | 70.1 | 91.0 | 75.9 | 78.1 | 86.2 | 76.9 | 85.8 | 84.2 | 124.2 | 126.0 |
| II | 78.1 | 103.1 | — | 89.5 | 93.4 | 88.0 | 89.7 | 93.9 | 137.9 | 136.9 |
| III | — | 108.3 | 86.3 | 89.1 | 91.4 | 90.1 | 88.1 | 95.0 | — | 142.3 |
| IV | — | 105.0 | 86.9 | 82.9 | 89.4 | 84.1 | 85.3 | 99.8 | 146.5 | 143.0 |
| Sucker diameter | 4.3 | 4.2 | 4.1 | 4.0 | 4.3 | 3.5 | 4.2 | 4.7 | 5.2 | 5.2 |
| Arm width | 5.8 | 7.0 | 6.0 | 7.1 | 6.1 | 5.2 | 6.0 | 7.1 | 7.4 | 11.3 |
| Gills | 14 | 13 | 13 | 12 | 15 | 14 | 13 | 14 | 13 | 14 |
| Web depth A | 17.4 | 19.2 | 19.2 | 17.4 | 18.3 | 23.5 | 16.0 | 20.0 | 24.8 | 25.0 |
| B | 15.9 | — | — | 19.5 | 20.0 | 17.1 | 18.3 | 21.9 | 26.4 | 20.4 |
| C | — | 23.2 | 17.5 | 23.2 | 25.3 | 21.8 | 16.1 | 24.1 | 32.5 | 31.9 |
| D | — | 24.8 | 21.9 | 15.8 | 17.0 | — | 18.2 | 24.5 | 31.9 | 30.8 |
| E | — | 19.0 | 12.0 | 17.8 | 18.1 | 16.8 | 19.1 | 16.5 | 27.1 | 26.8 |

TABLE 5 (Continued)

MEASUREMENTS (IN MM) AND COUNTS OF 11 MALES AND 20 FEMALES OF *Octopus selene*, NEW SPECIES

| | ♂ | ♂ | ♂ | ♂ | ♂ | ♂ | ♂ | ♂ | ♂ | ♂ | ♂ |
|------------------|------|------|------|------|------|------|------|------|------|------|------|
| Mantle length | 40.0 | 40.1 | 40.3 | 40.4 | 40.4 | 40.5 | 41.0 | 41.0 | 41.2 | 41.9 | 42.8 |
| Mantle width | 21.9 | 23.2 | 27.0 | 24.8 | 28.0 | 29.5 | 21.9 | 23.1 | 26.8 | 28.2 | 25.9 |
| Head width | 16.5 | 17.5 | 19.1 | 18.8 | 19.0 | 19.0 | 15.8 | 16.7 | 20.9 | 17.2 | 18.1 |
| Arm length I | 74.6 | 71.2 | 75.0 | 82.5 | 79.0 | 68.4 | 70.0 | 71.4 | 70.0 | 69.5 | 70.1 |
| II | 73.5 | 76.7 | 77.9 | 84.1 | 86.1 | 75.3 | 69.0 | 70.9 | 81.3 | 72.9 | 78.0 |
| III | 80.5 | 80.8 | 84.1 | — | 86.2 | 76.1 | 76.1 | 67.1 | 79.9 | 66.2 | 77.2 |
| IV | 78.1 | 76.1 | 76.8 | 83.2 | 84.1 | 73.4 | 73.0 | — | 72.9 | 66.5 | 77.0 |
| Hect. arm length | — | 67.5 | 64.1 | 68.0 | 62.0 | 56.8 | 58.6 | 56.6 | 63.1 | 55.4 | 61.2 |
| Ligula length | — | 4.2 | 5.1 | 6.0 | 6.2 | 3.8 | 4.0 | 3.3 | 4.7 | 4.0 | 5.6 |
| Calamus length | — | 1.1 | 0.8 | 1.0 | 0.6 | 1.0 | 0.77 | 0.6 | 0.9 | 0.6 | 1.28 |
| Sucker diameter | 3.7 | 3.5 | 4.5 | 3.5 | 4.5 | 4.1 | 3.6 | 4.1 | 4.2 | 4.0 | 4.5 |
| Arm width | 5.5 | 4.7 | 6.2 | 5.2 | 6.0 | 6.0 | 4.5 | 6.0 | 6.5 | 7.1 | 6.0 |
| Gills | 14 | 14 | 13 | 14 | 12 | 13 | 14 | 13 | 13 | 13 | 14 |
| Web depth A | — | 15.0 | 13.9 | 14.0 | 16.0 | 16.1 | 14.2 | — | 17.1 | — | 18.2 |
| B | 20.5 | 12.1 | 19.2 | 16.0 | 13.9 | — | 13.1 | — | 13.0 | 20.1 | — |
| C | 18.8 | 16.1 | 12.9 | 14.0 | — | 16.1 | — | — | 14.5 | 17.1 | — |
| D | 22.0 | 14.1 | 15.0 | 16.8 | — | 17.8 | — | 20.0 | 17.1 | 15.8 | — |
| E | — | 15.5 | 17.1 | 13.9 | — | 16.4 | — | — | 15.2 | 14.6 | 15.2 |

TABLE 6

INDICES OF BODILY PROPORTIONS OF 11 MALES AND 20 FEMALES OF *Octopus selene*, NEW SPECIES

| Character | ♂ Range & Mean | N | ♀ Range & Mean | N |
|----------------------|-------------------|----|-------------------|----|
| Mantle length | 40.4–40.9–42.8 | 11 | 40.0–44.6–58.1 | 20 |
| Mantle width index | 49.7–61.9–72.8 | 11 | 58.8–73.7–86.4 | 20 |
| Head width index | 38.5–44.1–50.7 | 11 | 29.5–45.6–63.4 | 20 |
| Arm length index | 56.2–60.7–65.9 | 11 | 57.4–62.0–68.2 | 19 |
| Mantle arm index | 47.9–51.8–57.4 | 11 | 37.6–47.4–55.0 | 19 |
| Arm width index | 10.9–14.1–16.9 | 11 | 11.4–14.8–19.4 | 20 |
| Web depth index | 18.5–22.2–28.0 | 11 | 20.4–24.7–29.5 | 19 |
| Sucker index | 8.6–9.9–11.1 | 11 | 7.4–9.3–11.3 | 20 |
| Hect. arm index | 72.0–77.5–83.5 | 10 | — — — | — |
| Ligula length index | 5.0–7.3–10.0 | 10 | — — — | — |
| Calamus length index | 15.0–19.4–26.3 | 10 | — — — | — |

***Octopus balboai*, new species**

Fig. 2, a-e

Material Examined.—HOLOTYPE: 1 ♂, mantle length 33.5 mm, from Chamé Point, Panamá, collected by Robert Tweedle, U. S. National Museum. USNM 577618.

Description.—The mantle is elongate-oval in outline, bluntly pointed posteriorly (MWI 68.7), and widest at about the midpoint. The head is only slightly narrower than the mantle width and is set apart from the mantle by a constriction in the neck region (HWI 65.6).

The mantle aperture is moderately narrow. The funnel is small but stout, and is free for about half of its length. The funnel organ is W-shaped, with thick apices and narrow, pointed limbs.

The web is shallow (WDI 23.9), with a formula of $D > E = C > B = A$, but there is little real difference between the sectors, which are about subequal.

The arms are long (ALI 68.7), stout at their bases (AWI 20.9), and taper to long, slender points. The web does not extend out the arms. The suckers are biserial, large (SIn 12.2), and crowded; none of them are conspicuously enlarged. In the male, the suckers of the distal third of the arms are curiously modified. The fleshy outer edge of each sucker bears a circlet of short, pointed papillae. These are visible only when the tips of the arms are immersed in liquid. The papillae then stand out plainly, giving the suckers a star- or flower-like appearance. This modification may be a sexual character similar to the modification of the arm tips in *Eledone*; this cannot be demonstrated until females have been collected and described.

The hectocotylized arm is short (HcAI 76.0), with a strongly inrolled ventral membrane forming the spermatophoral groove. The ligula is small (LLI 7.5), slender, and pointed, with a distinct median groove. The calamus (CLI 40.0) is not long, but it is stout and stands conspicuously erect.

There are six lamellae on each outer demibranch of the gills.

The viscera were not dissected in the unique specimen. However, the penis is large and crescent-shaped, with the duct entering at about the midpoint. A few partially degenerated spermatophores were found in Needham's sac. One of these is illustrated. These spermatophores are unusual, somewhat resembling the armored spermatophores of *O. dollfusi* and certain *Eledone* (*Acantheledone*). However, the "teeth" on the midportion of the spermatophore are more scalelike; the cap is also much simpler.

There is an ink sac deeply buried in the liver, its duct entering the rectum near the anal opening.

The color in alcohol is purplish brown, deeper on the dorsum of the mantle, with a few faint purplish flecks. The dorsum of the mantle, head, and arms is covered with small to large simple papillae, larger in the mantle. The eyes are surrounded by a group of closely set papillae, but there are no ocular cirrhi present.

Type.—U. S. National Museum 577618.

Type-Locality.—Chamé Point, Panamá.

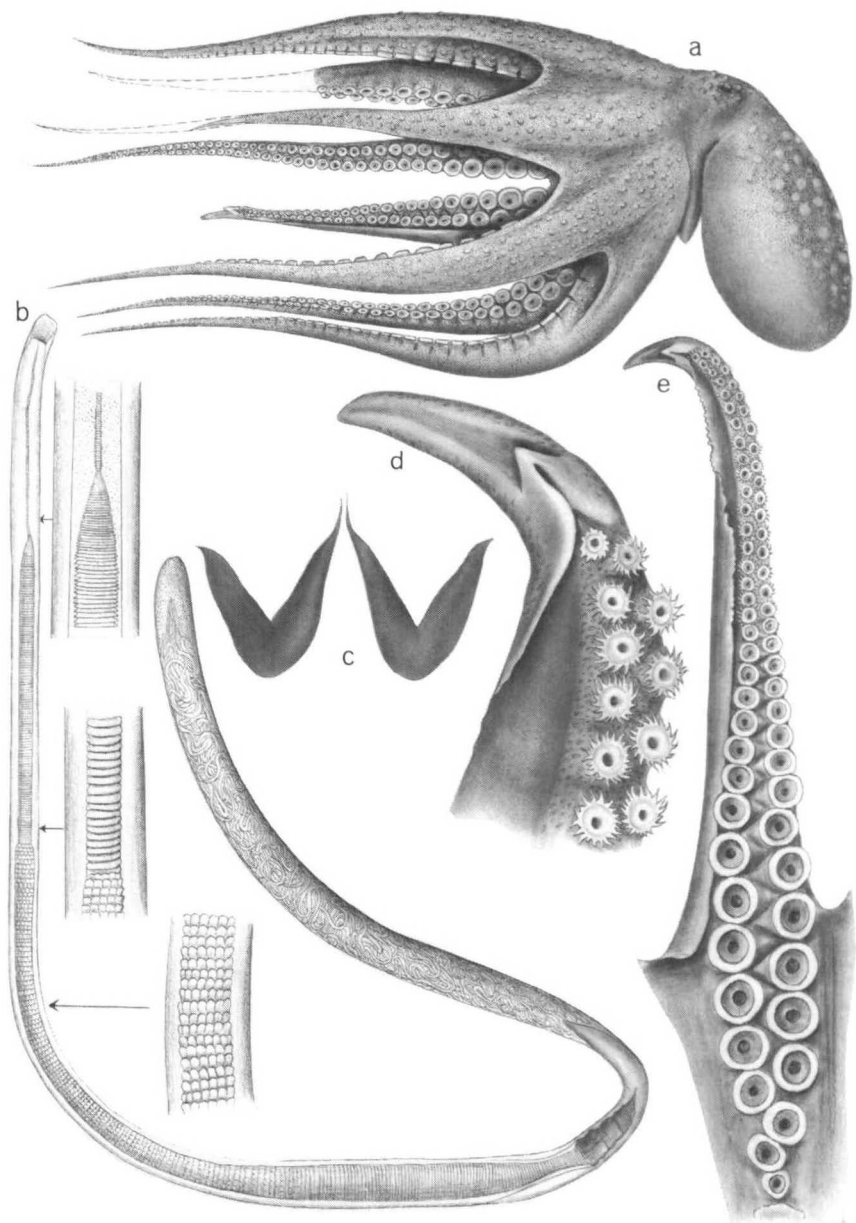


FIGURE 2. *Octopus balboai*, new species. Holotype, mantle length 33.5 mm: a, lateral view; b, spermatophore and enlarged sections; c, funnel organ; d, distal portion of hectocotylyzed arm; e, complete hectocotylyzed arm.

TABLE 7

MEASUREMENTS (IN MM) AND COUNTS OF THE HOLOTYPE OF *Octopus balboai*,
NEW SPECIES

| | | | |
|------------------|------|-----------------|------|
| Sex | ♂ | Sucker diameter | 4.1 |
| Mantle length | 33.5 | Arm width | 7.0 |
| Mantle width | 23.0 | Gills | 6 |
| Head width | 22.0 | Web depth A | 18.0 |
| Arm lengths: | L. | B | 18.0 |
| | | C | 20.0 |
| I | 75.0 | D | 21.0 |
| II | 65.0 | E | 20.0 |
| III | 81.0 | | |
| IV | 88.0 | | |
| Hect. arm length | 67.0 | | |
| Ligula length | 5.0 | | |
| Calamus length | 2.0 | | |

TABLE 8

INDICES AND FORMULAE OF BODILY PROPORTIONS OF THE HOLOTYPE OF
Octopus balboai, NEW SPECIES

| | | | |
|--------------------|------|----------------------|-------------------|
| Mantle width index | 68.7 | Sucker index | 12.2 |
| Head width index | 65.6 | Hect. arm index | 76.0 |
| Arm length index | 68.7 | Ligula length index | 7.5 |
| Mantle arm index | 38.1 | Calamus length index | 40.0 |
| Arm width index | 20.9 | Arm formula | 4.2.3.1 |
| Web depth index | 23.9 | Web formula | D > E = C > B = A |

Discussion.—This species is known only from the single specimen in the collections of the U. S. National Museum. In general appearance, it resembles a deep-water octopod. It is unfortunate that no other material is available.

Remarks.—The specific name is derived from the name of the first European to see the Gulf of Panamá—Vasco Nuñez de Balboa.

***Octopus stictochrus*, new species**

Figs. 3, a-e; 4, a-e

Material Examined.—HOLOTYPE: ♀, mantle length 19 mm, PILLSBURY Sta. 535, 8°38.6'N, 78°51.9'W, between the Perlas Islands and Río Hondo, Panamá, in 31 meters with 10-ft OT, May 6, 1967. USNM 577619.

PARATYPE: ♀, mantle length 20 mm, PILLSBURY Sta. 492, 7°50.7'N,

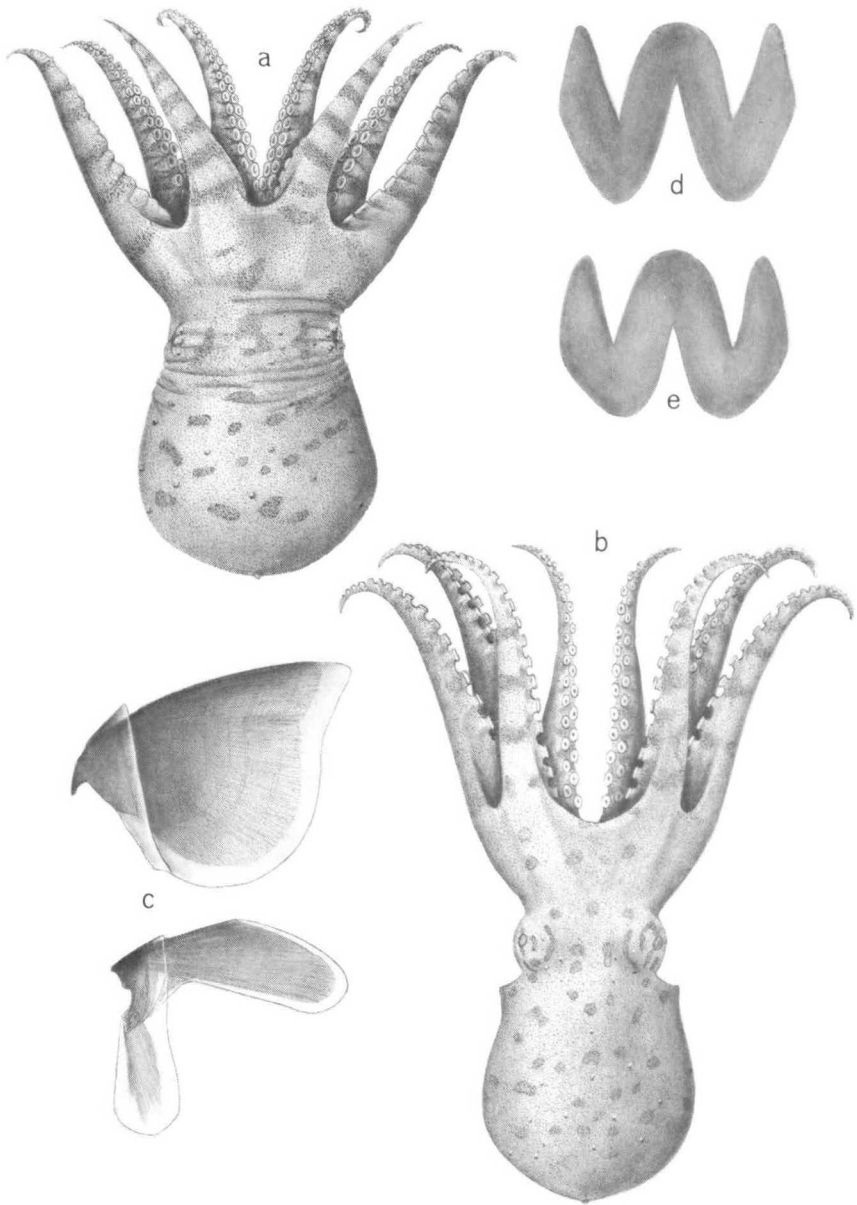


FIGURE 3. *Octopus stictochrus*, new species: a, dorsal view of holotype, mantle length 19 mm; b, dorsal view of paratype, mantle length 20 mm; c, upper and lower beaks of holotype; d, funnel organ of holotype; e, funnel organ of paratype.

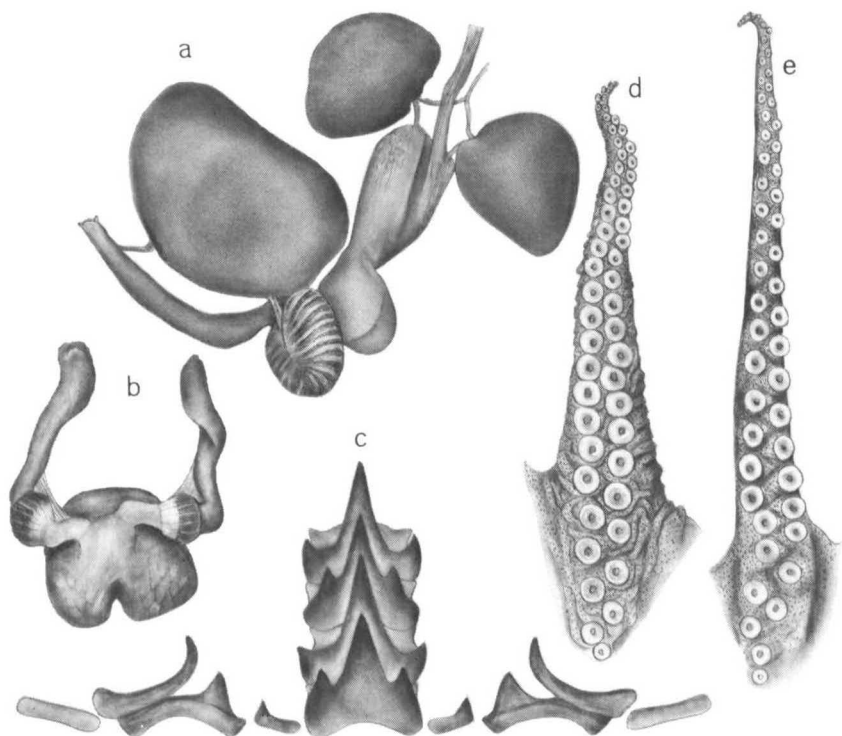


FIGURE 4. *Octopus stictochrus*, new species: a, digestive tract of paratype; b, female reproductive tract of paratype; c, radula of paratype; d, arm of holotype; e, arm of paratype.

80°09.8'W, off Isla Villa, Panamá, in 16-18 meters with 10-ft OT, May 2, 1967.

Description.—This is a small species of octopus, unfortunately represented only by female specimens, one of which seems to be gravid. The mantle is short, stout, and somewhat squarish posteriorly, decidedly wider near the end (MWI 90.0-100). There is no constriction between the head and the mantle, and the head is narrower than the mantle width (HWI 62.5-73.7).

The funnel is short and stout, with broad basal shoulders. It is free for about half its length. The funnel organ is W-shaped, with rather thick limbs.

The web is moderately deep (WDI 30.2-37.5) and subequal, with sector A slightly shallower than the others. The web formula is D.C.E.B.A. in both specimens. The web does not extend up the sides of the arms in either example.

TABLE 9
MEASUREMENTS OF THE HOLOTYPE AND PARATYPE OF *Octopus stictochrus*,
NEW SPECIES

| | Holotype ♀ | Paratype ♀ | | Holotype ♀ | Paratype ♀ |
|-----------------|---------------|---------------|--------------|---------------|---------------|
| Mantle length | 19.0 | 20.0 | Arm width | 4.0 | 3.5 |
| Mantle width | 19.0 | 18.0 | Gills | 7 | 6 |
| Head width | 14.0 | 12.5 | Total length | 60.0 | 66.0 |
| Arm length I | 31.0 | 39.0 | Web depth A | 11.0 | 10.5 |
| II | 33.0 | 40.0 | B | 11.5 | 10.5 |
| III | 36.0 | 41.0 | C | 12.5 | 12.0 |
| IV | 36.0 | 41.0 | D | 13.5 | 12.5 |
| | | | E | 12.0 | 11.0 |
| Sucker diameter | 1.6 | 1.3 | | | |

The arms are short (ALI 60-62; MAI 48.7-52.8) and rather stout at the web margin (AWI 17.5-21.0). They show the formula $3 = 4.2.1$, but are subequal with no disparity between pairs. The suckers are in two rows, small (SIn 6.5-8.4), and evenly spaced.

The gills are large and broad, but have only six or seven lamellae on each demibranch.

The mandibles are as figured and show no distinctive features.

The radula is somewhat unusual. The rachidian teeth show an A^{2-3} seriation. The admedians are small and low, but have a single, distinct, erect ectocone near the outer end of the tooth. The second lateral is long with a subterminal endocone. The third lateral is sabrelike. The marginals are well developed, long, and slender.

The digestive tract is of the usual type. The second salivary glands are large and leaflike. The crop is well developed. The spiral caecum is larger than the stomach, dark gray, and marked with white transverse lines. The large intestine is undivided. The ink sac is set into the liver.

The female genitalia were dissected. The ovary is small and undeveloped. The proximal oviduct is short and stout. The oviducal gland is dark gray, with white ribbing; the distal oviducts are large.

The color in alcohol is light mauve brown dorsally and ventrally on the mantle, head, and arms. On the mantle there are about six or seven transverse, irregular rows of large dark spots. These extend midway down the sides, but are absent on the ventral surface. These are somewhat fused around the eyes. The spots extend out onto the arm bases, but, just proximal of the border of the web, there appear bands that, beyond the web, extend across the arms from sucker base to sucker base. There are

TABLE 10
 INDICES OF BODILY PROPORTIONS OF HOLOTYPE AND PARATYPE OF *Octopus stictochrus*, NEW SPECIES

| | Holotype | Paratype |
|--------------------|----------|----------|
| Mantle width index | 100.0 | 90.0 |
| Head width index | 73.7 | 62.5 |
| Arm length index | 60.0 | 62.0 |
| Mantle arm index | 52.8 | 48.7 |
| Arm width index | 21.0 | 17.5 |
| Web depth index | 37.5 | 30.2 |
| Sucker index | 8.4 | 6.5 |

about six to nine bands across all arms in the specimen from Sta. P-535 (Fig. 1,a); the other specimen (Fig. 1,b) is not distinctly banded, the bands being replaced by more irregular brown spots. There is no evidence of any sculpture; the surface is smooth.

Type.—U. S. National Museum 577619.

Type-Locality.—PILLSBURY Sta. 535, 8°38.6'N, 78°51.9'W, between the Perlas Islands and Río Hondo, Panamá, in 31 meters with 10-ft OT, May 6, 1967.

Discussion.—This species seems to be distinctive, and I know of no other species which resembles it, either along the west coast of the Americas or in the Pacific islands. The characteristic color makes it easily recognizable.

These two specimens were found in the same tows with *O. chierchiae*. A brief listing of other benthic animals shared in both tows is given in the notes regarding the latter species.

The name *stictochrus* is derived from the Greek *stictos* and *chróos* meaning "with spotted skin."

Octopus chierchiae Jatta, 1889

Octopus chierchiae Jatta, 1889: 64; 1899: 19, pl. 1, figs. 3-14.—Robson, 1929: 152.—Voss, 1968: 652, fig. 1, b, fig. 2, g-h, fig. 3, f-j, fig. 4, e-f.

Material Examined.—1 ♀, mantle length 29 mm, PILLSBURY Sta. 492, 7°50.7'N, 80°09.8'W, off Isla Villa, Panamá, in 16-18 meters with 10-ft OT, May 2, 1967.—1 ♀, mantle length 18.5 mm, PILLSBURY Sta. 535, 8°38.6'N, 78°51.9'W, between the Perlas Islands and Río Hondo, Panamá, in 31 meters with 10-ft OT, May 6, 1967.

This beautiful small species of banded octopus was taken at only two stations, both times in company with a small spotted octopus, *Octopus*

stictochrus. It was described and figured by Jatta from material collected by the VETTOR PISANI from the Gulf of Panamá. It was figured by Voss (1968) and compared in detail with its twin Caribbean species, *Octopus zonatus*. Both of the above specimens were immature.

Field notes taken at the time (Voss, 1967) show that the two localities, although at opposite ends of the gulf, shared a number of genera: *Conus*, *Distorsio*, *Chione*, *Tellina*, and *Turris* among mollusks; *Hepatus*, *Raninoides*, *Sicyonia*, and *Squilla* among crustaceans; and *Symphurus*, *Porichthys*, and genera of bothids and gobies among the fishes.

This species is now known to occur from the Gulf of Panamá to El Salvador.

? *Octopus oculifer* (Hoyle, 1904)

?*Octopus bimaculatus* Verrill, 1883: 122 (specimen listed from Panamá and San Salvador; not *O. bimaculatus* Verrill, 1883, from California).

?*Polypus oculifer* Hoyle, 1904: 14, pl. 4, figs. 3, 4.

Material Examined.—1 ♀, mantle length 10.3 mm, Isla Saboga, Canal de Santiago, February 10, 1948, Coll. Paul S. Goltsoff, U. S. National Museum.

A small specimen of ocellated octopus was found in the U. S. National Museum collections of Panamanian cephalopods. The specimen is an immature female. The skin is rough, with numerous small tubercles and scattered, tall, erect papillae; a cirrus occurs over each eye. The ocellus is composed of a light outer ring, a dark band inside, and a pale center. There are about ten lamellae on the outer demibranch of the gill.

An additional specimen of what appears to be the same species was taken by Charles E. Dawson on the Pacific coast of Costa Rica at Guana-caste, Playa el Coco, with fish poison from a tide pool. This is a young male with a mantle length of 14.0 mm.

The identity of these specimens must remain in doubt until all available specimens are studied and the group revised. Pickford (1945) and Pickford & McConnaughey (1949) have pointed out the existence of an unnamed species of ocellated octopus in the Panamanian region. Examination of the two specimens listed above shows that this species is very close to Hoyle's *Polypus oculifer* from the Galapagos Islands, and, until such time as the necessary studies have been made, I am referring the present specimens to this poorly known species.

? *Octopus vulgaris* Cuvier, 1797

Material Examined.—2 ♀, mantle length 18.0-31.0 mm, Bahia Santelmo, Isla del Rey, Perlas Islands, Panamá, with fish poison along rocky shore, August 1, 1968. Coll. Charles E. Dawson.

The two very granulose specimens are tentatively referred to this species.

Both are young females, and no good characters are available. The gills have about ten lamellae per outer demibranch, and the funnel organ is W-shaped. The smaller specimen has a considerably elongated mantle; the larger specimen is more usual in appearance.

Octopus sp.

Material Examined.—1 ♀, mantle length 32.0 mm, PILLSBURY Sta. 531, 8°25.5'N, 79°10.7'W, west of the Perlas Islands, Panamá, in 57-64 meters with 10-ft OT, May 6, 1967.

The single immature female has no distinctive features sufficient to yield an identification and does not seem referable to any of the known species of the area.

Octopus Eggs

Material Examined.—Clutch of about 100 eggs in venerid shell from PILLSBURY Sta. 535.

A clutch of about 100 eggs measuring 7.0×3.0 mm was recovered in a venerid valve at this station. The eggs are in a single layer attached terminally by a short thin stalk. At the present state of our knowledge of the Panamic octopods, it is not possible to assign these with certainty to any of the known Panamic species. Robson (1929:199) remarked that the eggs of *O. digueti* Perrier & Rochebrune (1894) from the Gulf of California are laid in bivalve shells in groups of two to five with the thin stalk attached to the shell in the middle of a circular or oval dark patch. The same is true of the present eggs, the dark patches being particularly noticeable against the white surface of the shell.

***Euaxoctopus panamensis*, new genus and new species**

Figs. 5, a-c; 6, a-j

Material Examined.—HOLOTYPE: ♂, mantle length 26.0 mm, PILLSBURY Sta. 493, 7°39.5'N, 80°00.7'W, north of Isla Iguana near Punta Mala, Panamá, in 37-33 meters with 10-ft OT, May 2, 1967. USNM 577620.

PARATYPES: 2 ♂, mantle length 21.0-32.0 mm, 2 ♀, mantle length 20.0-29.0 mm, PILLSBURY Sta. 493, with holotype.—1 ♂, mantle length 25.0 mm, PILLSBURY Sta. 533, 8°45.2'N, 79°10.3'W, northwest of the Perlas Islands, Panamá, in 37-33 meters with 10-ft OT, May 6, 1967.—1 ♀, mantle length 14.5 mm, seaward of Teacher Ferry Bridge, canal bottom, from dredge flume, Panama Canal, March 16, 1967. USNM 576454.

Description.—This unusual species of octopod is represented in the collections by six specimens, most of which, with the exception of broken arms, are in excellent condition.

The mantle is ovoid, somewhat slender and bluntly pointed posteriorly

(MWI 47.5-53.6-59.3). There is a strong constriction between the mantle and the head. The neck region is long and conspicuous; the head is narrow with small, protuberant eyes (HWI 31.7-36.8-42.5).

The funnel is long and slender and free for about $\frac{1}{3}$ to $\frac{1}{2}$ of its length. The funnel organ is VV-shaped, with long, slender arms.

The web is very shallow, but, because of the frequent mutilation of the arms, the depth is difficult to measure. Only two specimens (Nos. 1 and 5) had intact long arms. These yielded web depth indices of 8.7 and 8.8, respectively. The web sectors were about equal in depth, with E usually being the shallowest; in one specimen, however, E was the deepest.

The arms are long (for three nearly complete specimens, ALI 80.0-81.6-84.0; MAI 15.8-18.3-20.8) and slender (AWI 11.9-13.9-15.4). Since the AWI is calculated as a percentage of the mantle length, it does not in this case portray the true nature of the slenderness of the arms. Arms II and III seem regularly to be longest, and IV the shortest, but because of arm breakage and partial regeneration the arm formula is not certain. The suckers are in two rows, small (SIn 5.2-6.3-8.0), widely spaced, and erect. There was no indication of specially enlarged suckers in the males.

In the three males the third left arm is hectocotylized. This arm is much shorter than its fellows (HcAI 25.6-26.8-28.0) and bears a small, slender ligula at its tip (LLI 6.0-7.6-9.2). The ligula is narrow and pointed, with a broad groove, strongly inrolled margins, and numerous fine transverse lines. The calamus is short, stout, and about $\frac{1}{3}$ to $\frac{1}{2}$ the length of the ligula (CLI 32.4-46.1-54.0). The arm is bordered ventrally by an expanded web, but there is no distinct spermatophoral groove.

The gills contain about 11 lamellae per demibranch, but two specimens have 12 and 13, respectively (gills 11-13).

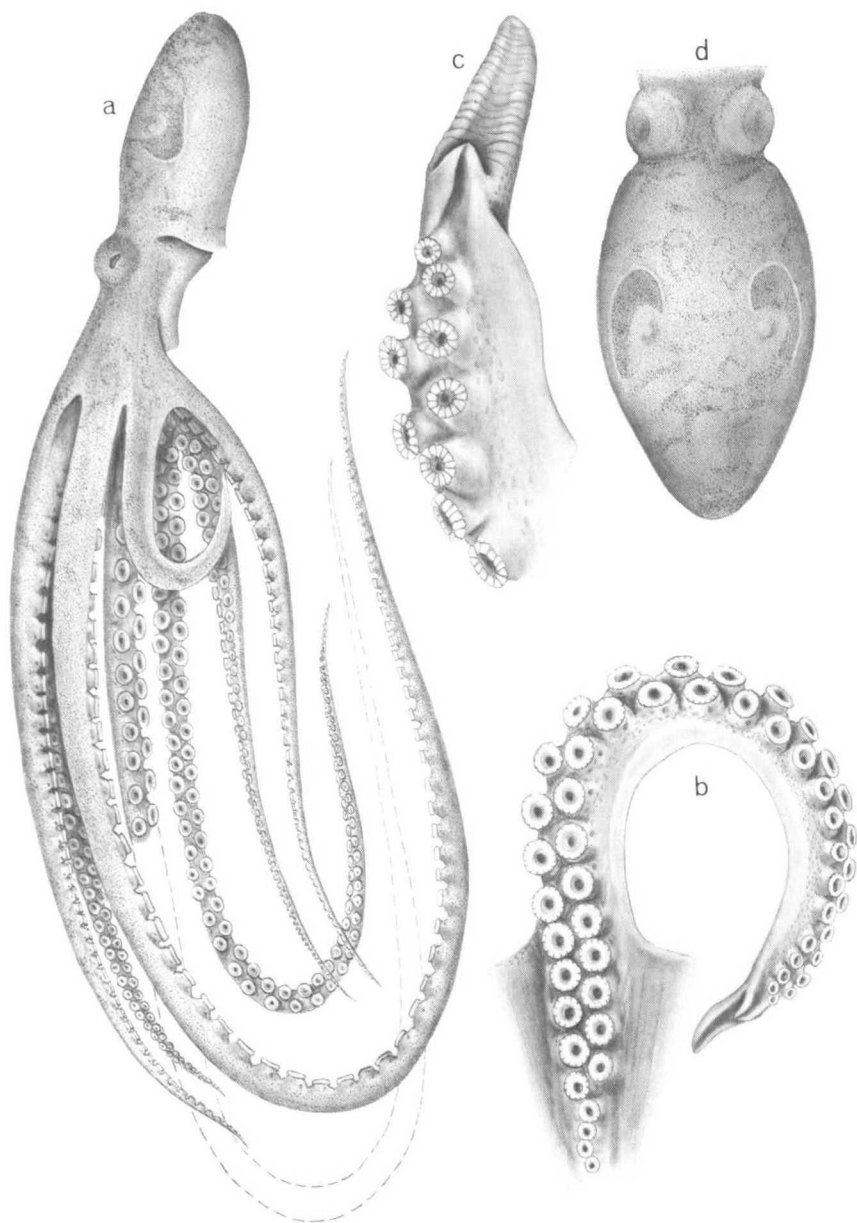
The mandibles are as figured.

The radula is not unusual nor distinctive. The rachidian teeth have an A² seriation, with a single large cusp on each side. The admedian is short and stout, with a blunt ectocone. The second laterals are long, with a heavy broad endocone. The third laterals are sabrelike. The marginals are rectangular and poorly developed.

The digestive tract was removed from the largest male (No. 4). It shows a number of unusual features. The posterior salivary glands are of unequal size; the left gland is about twice the size of the right, and both

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FIGURE 5. *Euaxoctopus panamensis*, new genus and species: a, lateral view of holotype, mantle length 26 mm; b, hectocotylized arm of holotype; c, hectocotylus of holotype; d, dorsal view of mantle and head, showing size and shape of ocellus.



appeared to be fused together to form a cap dorsally and anteriorly over the crop. The glands could be teased apart, but were actually fused though they had separate ducts.

The crop is large and well developed, with the oesophagus entering dorsally. From the crop, the oesophagus runs posteriorly along the dorsal surface of the liver to become a large, soft stomach fused to a small, striated, spiral caecum. The stomach-spiral caecum complex possesses two poorly developed ducts leading to the posterior end of the liver. The intestine is partially convoluted; the terminal pore is protected by lateral winged flaps. The liver is very elongate and rather slender and posteriorly is broadly cleft with large out-turned flaps. There is a well-developed ink sac partially buried in the liver, with a duct entering the rectum just proximal of the anal opening.

The female genitalia were dissected in specimen No. 3. The ovary was large and contained a mass of nearly ripe, small eggs about 1.4×0.5 mm, with small stalks. The proximal oviducts have a common origin and then divide to lead to large, grayish black oviducal glands. The distal oviducts are short.

The male genitalia were also dissected, but showed no unusual features. The penis is small, swollen, elongate oval, with the duct coming in near the anterior pore. In specimen No. 1 there were a number of fully formed spermatophores, one of which is illustrated. This shows a number of unusual features, such as the lack of a cement body and the odd terminal region.

The color in alcohol is a light grayish tan, with darker mottling on the dorsum of the head, arms, and mantle. The most prominent feature is the presence of a peculiar ocellus (?) on each side of the mantle, slightly dorsal and at about the midpoint between the neck region and the end of the body. The ocellus consists of a light bluish or pinkish crescentic line, the anterior end slightly more turned in, enclosing a darkly pigmented semi-circular splotch. In life this ocellus was very conspicuous, but did not have the luminous glow of the usual ocellus. It disappeared at first on preservation in formalin, but reappeared after a short period and is conspicuous in alcohol.

The dorsum of the head, arms, and mantle is variously sculptured. The skin is nearly smooth in some, rugose in others, and has widely separated papillae in others. It can best be described as conspicuously sculptured but variable.

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FIGURE 6. *Euaxoctopus panamensis*, new genus and species: a, digestive tract; b, dorsal view of liver; c, female reproductive tract; d, male reproductive tract; e, penis; f, upper and lower beaks; g, radula; h, funnel organ; i, funnel organ; j, spermatophore.

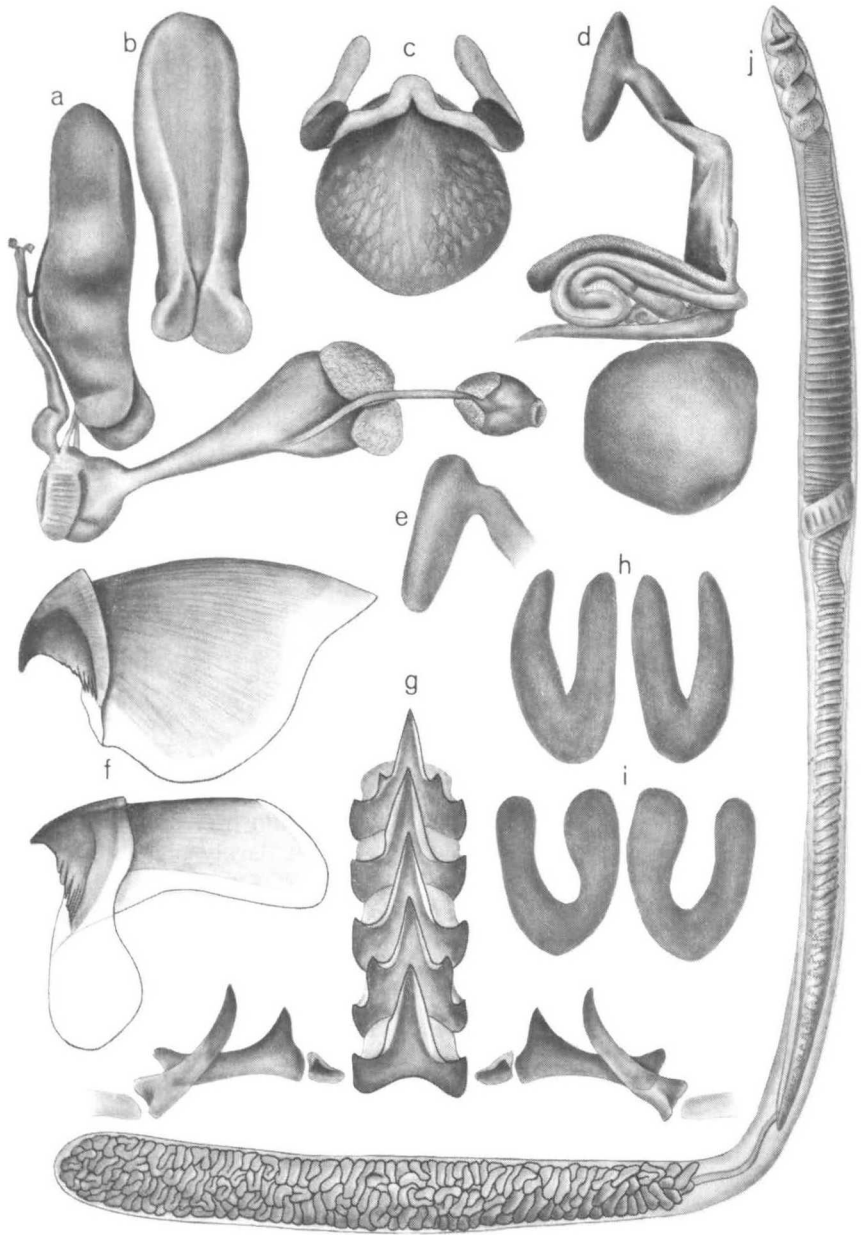


TABLE 11
MEASUREMENTS (IN MM) AND COUNTS OF THE HOLOTYPE AND FIVE PARATYPES OF *Euxoctopus panamensis*, NEW SPECIES

| | 1 | 2 | 3 | 4 | 5 | 6 |
|------------------|-------|-------|------|-------|-------|-------|
| Sex | ♂ | ♀ | ♀ | ♂ | ♂ | ♂ |
| Mantle length | 25.0 | 20.0 | 29.0 | 32.0 | 26.0 | 21.0 |
| Mantle width | 14.0 | 11.0 | 14.5 | 19.0 | 14.0 | 10.0 |
| Head width | 9.0 | 8.5 | 9.2 | 12.0 | 8.9 | 8.2 |
| Arm length I | 89.0 | 87.0 | 18+ | 97+ | 95.0 | 90.0 |
| II | 80.0R | 84.0 | 25+ | 154+ | 164.0 | 65+ |
| III | 38.0 | 136.0 | 20+ | 26+ | 42.0 | 108.0 |
| IV | 69.0 | 69.0 | 74.0 | 100.0 | 70.0 | 54.0 |
| | | | | 81+ | 65.0 | 54.0 |
| Hect. arm length | 38.0 | — | — | — | 42.0 | 34.0 |
| Ligula length | 3.5 | — | — | — | 2.5 | 2.4 |
| Calamus length | 1.1 | — | — | — | 1.3 | 1.3 |
| Sucker diameter | 1.5 | 1.6 | 1.6 | 1.8 | 2.0 | 1.1 |
| Arm width | 3.5 | 3.0 | 3.5 | 4.0 | 4.0 | 2.5 |
| Gills | 11 | 11 | 12 | — | 12 | 13 |
| Web depth A | 9.5 | 8.0 | 11.0 | — | 9.0 | 8.5 |
| B | 11.5 | 8.0 | 11.0 | — | 11.0 | 8.5 |
| C | 11.0 | 9.0 | 11.5 | — | 11.0 | 8.0 |
| D | 11.0 | 9.0 | 11.0 | — | 10.0 | 8.0 |
| E | 12.0 | 8.0 | 11.0 | — | 8.0 | 7.5 |

R = regenerating arm tip.

+ = arm broken, with part missing.

TABLE 12

INDICES OF BODILY PROPORTIONS OF HOLOTYPE AND PARATYPES OF *Euaxoctopus panamensis*, NEW SPECIES

| Character | N | Range & Mean |
|------------------------|---|----------------|
| Mantle width index | 6 | 47.5-53.6-59.3 |
| Head width index | 6 | 31.7-36.8-42.5 |
| Arm length index | 3 | 80.0-81.6-84.0 |
| Mantle arm index | 3 | 15.8-18.3-20.8 |
| Arm width index | 6 | 11.9-13.9-15.4 |
| Web depth index | 2 | 8.7-8.75- 8.8 |
| Sucker index | 6 | 5.2- 6.3- 8.0 |
| Hect. arm length index | 2 | 25.6-26.8-28.0 |
| Ligula length index | 3 | 6.0- 7.6- 9.2 |
| Calamus length index | 3 | 32.4-46.1-54.0 |

Type.—U. S. National Museum, 577620.

Type-Locality.—PILLSBURY Sta. 493, 7°39.5'N, 80°00.7'W, north of Isla Iguana near Punta Mala, Panamá, in 37-33 meters with 10-ft OT, May 2, 1967.

Discussion.—The appearance of a third genus of octopodines with the hectocotylus on the third left arm seems needful of some special comments. All of the known octopodines, with the exception of *Scaeurus* and *Pteroctopus*, have the hectocotylus on the third right arm. Robson (1929) discussed this feature, both in his general considerations and under each of the two genera mentioned above. The genera *Scaeurus* and *Pteroctopus* have little in common and do not seem related.

The present genus seems to have developed in shallow water as has *Scaeurus*, but again, no close relationship seems evident. It is easily distinguished from *Scaeurus* by the elongate body, VV-shaped funnel organ, the very long arms, shallow web, and the ink sac deeply involved in the liver.

As known, it represents a genus endemic to the Gulf of Panamá, with no representative or close ally in other regions of the world.

Remarks.—The name *Euaxoctopus* is derived from the Greek *euaxos*, "easily broken," and refers to the tendency for the arms to break off the brachial crown.

Family Argonautidae

Argonauta pacificus Dall, 1872

Argonauta pacificus, Keen, 1958: 514, fig. 3.

Material Examined.—1 ♀, alive with shell, eggs, and hatching larvae, mantle length 43.0 mm, PILLSBURY Sta. 529, 8°00.7'N, 79°11.8'W, south

of Isla de San José, Perlas Islands, Panamá, in 84 meters with 10-ft OT, May 6, 1967.

The single female was taken along with eggs and hatching larvae. The shell was apparently crushed in the open trawl. The animal checks out very favorably with the brief description of this species given by Dall (1908). However, a full and detailed study of *pacificus* and *argo* is needed to determine whether they are conspecific, as some authors have considered them, or if they are indeed separate species.

Argonauta cornutus Conrad, 1854

Argonauta cornutus, Keen, 1958: 514, fig. 1.

Material Examined.—2 shells, 1 broken, 1 length 45.0 mm, PILLSBURY Sta. 533.—3 broken shells, PILLSBURY Sta. 500.—1 broken shell, PILLSBURY Sta. 519.—1 immature shell, length 14.0 mm, PILLSBURY Sta. 561.—1 shell, length 25.0 mm, PILLSBURY Sta. 530.—1 broken shell, PILLSBURY Sta. 549.—1 broken shell, PILLSBURY Sta. 555.—1 broken shell, PILLSBURY Sta. 532.—1 shell, length 42.0 mm, PILLSBURY Sta. 531.—1 shell, length 42.0 mm, PILLSBURY Sta. 513.—1 broken shell, PILLSBURY Sta. 496.—3 shells, lengths 21.0, 26.0, and 32.0 mm, PILLSBURY Sta. 529.—1 broken shell, PILLSBURY Sta. 517.

Argonauta cornutus was very briefly and inadequately described by Conrad in 1854. The description was supplemented by a figure which shows several characters of importance, in particular the large, scattered tubercles on the midportion of the keel. The large series taken by the PILLSBURY was all from dead animals and was taken from the bottom in otter trawl catches, thus no soft parts are available. The shells, however, were carefully compared with those of whole animals from billfish stomachs from off Ecuador and Peru and were found to be similar in all respects.

A. cornutus seems best characterized by the few radial ribs, the presence of fine sharp tubercles or papillae over the sides of the shells, the few, rather sharp, large carinal tubercles on each edge, the *convex* carinal surface, and the few, large, blunt tubercles on the carinal surface between the two rows of carinal boundary tubercles.

Argonauta nouryi Lorois, 1852

Argonauta nouryi, Keen, 1958: 514, fig. 2.

Material Examined.—3 shells, partially broken, lengths 37.0, 46.0, and 57.0 mm, PILLSBURY Sta. 512.—1 shell, length 30.0 mm, PILLSBURY Sta. 373.—2 shells, 1 broken, 1 length 35.0 mm, PILLSBURY Sta. 519.—1 shell, length 42.0 mm, PILLSBURY Sta. 529.—1 broken shell, PILLSBURY Sta. 553.

Argonauta nouryi is a distinctive species fairly well represented in the PILLSBURY material. All of the shells were from dead animals taken on

the bottom with the otter trawl. The shells are longer than in other species of *Argonauta*, the ribs are more numerous, there are no distinct tubercles marking the edges of the carinal area; the carina is wide, very convex, and covered by numerous, small, blunt tubercles formed by the crisscrossing of the ribs. Unfortunately, no soft parts are available.

SUMARIO

CEFALÓPODOS COLECTADOS POR EL BARCO DE INVESTIGACIONES JOHN ELLIOTT PILLSBURY EN EL GOLFO DE PANAMÁ EN 1967

Se revisa la fauna de cefalópodos del Golfo de Panamá, basándose principalmente en colecciones hechas por el barco de investigaciones JOHN ELLIOTT PILLSBURY durante 1967. Se dan reportes de 812 ejemplares, de los cuales cuatro especies y un género son nuevos para la ciencia: *Octopus selene*, *O. balboai*, *O. stictochrus* y *Euaxocephalus panamensis*. Ahora se conocen 26 especies en el Golfo, de las cuales 11 constituyen reportes registrados aquí por primera vez. Se discuten las relaciones de la fauna del Golfo de Panamá con las del Pacífico oriental y sudoeste del Mar Caribe.

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